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# POST-BREEDING SEASON HABITAT USE AND MOVEMENTS OF EASTERN MEADOWLARKS IN SOUTHWESTERN WISCONSIN

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ABSTRACT.—We used radio telemetry to study post-breeding movements of adult female and juvenile Eastern Meadowlarks (*Sturnella magna*) in southwestern Wisconsin in 2002–2004. Twenty-one adult females were found 58% of the time in their nest field regardless of nest fate. Three adult females were not found outside of the field where their nests were located. Fifteen of 18 females that moved from the nest field at least once moved to Conservation Reserve Program fields or pasture. The average maximum distance females moved was 662 m. Once females left the nest field, 61% did not return. Twelve juveniles from different broods survived to the end of the post-breeding season. Two juveniles did not move from their nest fields during the monitoring period. Eight of 10 juveniles that moved at least once moved into Conservation Reserve Program fields, remnant prairie or pasture. The average maximum distance moved by juveniles was 526 m. Once juveniles started to leave the nest field, 67% did not return. Grassy habitats appear to be important in the post-breeding period for Eastern Meadowlarks. Management should be directed toward maintaining or enhancing the amount and quality of those habitats. *Received 10 July 2006. Accepted 21 October 2006.*

Most management of habitat to benefit grassland (and other) birds has focused on the breeding season. Current recommendations for management of grasslands emphasize delaying activities such as mowing until after the peak of nesting activity (Sample and Mossman 1997). This delay may reduce losses of nests to human disturbance but ignores the needs of fledglings and adults during the critical time from fledging of young to fall migration. The time from when a young bird fledges until breeding age is the least understood portion of the life cycle (Baker 1993) and is virtually unstudied for most species. This is a critical period when birds are learning to fly, find food, and survive on their own. Survival of young during this period may be enhanced by providing critical habitat needed for foraging, shelter, and escape from predators. Birds may require different habitats or habitat conditions depending on the time of year (Baker 1993, Anders et al. 1997, Suedkamp Wells 2005). Managers should know the habitat requirements of species in all seasons if they are going to protect existing habitat, or alter current conditions or practices for the benefit of a species.

Some telemetry work has been accomplished on movement of juvenile forest birds (e.g., Wood Thrush [*Hylocichla mustelina*]) (Anders et al. 1997) and several studies have recently examined post-breeding-season movements of individual juvenile (Yackel Adams 2001, Kershner et al. 2004b, Suedkamp Wells 2005) and adult grassland birds (Kershner et al. 2004a, Walk et al. 2004). Describing habitat use was the primary objective in only one of these studies (Suedkamp Wells 2005).

The objectives of our study were to assess habitat use and movements of adult (2002–2004) and juvenile (2003–2004) Eastern Meadowlarks (*Sturnella magna*) during the post-breeding period using radio telemetry. We chose the Eastern Meadowlark because it is a common nesting species in the study area (Guzy 2005) and is sufficiently large to carry a transmitter with a battery life to potentially last through the summer.

## METHODS

*Study Area.*—This study was conducted in western Dane, eastern Iowa, and northern Green counties in Wisconsin bounded on the north by State Highway 18–151 from approximately Mount Horeb on the east to Ridgeway on the west. The study area was 33,413 ha in size and is referred to as the Military Ridge Prairie Heritage Area (MRPHA). The

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MRPHA is in the Driftless Area which was unglaciated during the last glacial period. The topography is a series of ridges and valleys south from Military Ridge, an east-west ridge that extends from west of Madison (near Mount Horeb) west to where the Wisconsin River flows into the Mississippi River. Historically, ridge tops were mixed-grass prairie and valleys were savanna (Curtis 1959, Cochrane and Iltis 2000).

Modern land use in southwestern and southcentral Wisconsin is primarily agricultural, with a large portion of the land in pasture, hay, and small grains with relatively few hectares of corn (*Zea mays*) and soybeans (*Glycine max*) compared to other areas of Wisconsin. The MRPHA was digitized from digital orthophotos and the land use of each polygon was field verified. Approximately 27% of the land area was in pasture and idle grass. The MRPHA has numerous prairie remnants (most privately owned, but some are owned by The Nature Conservancy and the Wisconsin Department of Natural Resources) and high enrollment in the Conservation Reserve Program (CRP) (Economic Research Service 1995). It is within the boundaries of a Conservation Reserve Enhancement Program area which provides funds for long-term and permanent conservation easements.

*Trapping and Telemetry.*—All birds were handled in accordance with University of Wisconsin-Madison Animal Care and Use Protocol 07-6900-A01023-1-04-01. Meadowlarks were captured while on or near the nest. Nine CRP fields (average [± SE] size = 10.2 ± 1.3 ha, range 4.8–18.2 ha), four pastures (average size = 7.6 ± 0.7 ha, range 6.0–9.5 ha), and seven remnant prairies (average size = 8.3 ± 1.4 ha, range 3.5–13.3 ha) were searched for nests during May–July 2002–2004. Nest plots were chosen based on habitat type, minimum size, condition of vegetation, and uniformity of vegetation within a patch (e.g., abrupt transitions in structure were avoided). Each nest plot was searched by dragging a rope (2002) or personnel walking in a line across the area (2002–2004). Once a nest was located, a 1.5-m diameter bow net was placed at the nest along with a remote video camera (2002–2003). A video cable and trigger cord were used so the observer/trapper could be 25 m from the nest. The video camera was used to observe when an adult returned to the nest; once an adult was present, the net was released via a cord attached to the trigger. No adults were injured due to use of bow nets. Efforts were made to minimize the possibility of adults abandoning the nest when using bow nets by only trapping at nests that were well into incubation or when there were chicks in the nest. However, two nests were abandoned because of use of the bow net in 2003. Thus, in 2004, two 12-m long mist nets were placed near each nest and birds were captured either returning to or flushing from the nest.

A Federal aluminum band with a unique number and a unique combination of three color bands were placed on the bird's legs once an adult was captured. A 1.85-g Holohil BD-2G radio transmitter (Holohil Systems Ltd., Carp, ON, Canada) was placed on birds weighing >60 g (i.e., the transmitter was at or under the 3% of body weight limit required by the Bird Banding Laboratory). The transmitter was attached using an elastic harness, modified from Rappole and Tipton (1991), around the legs; this method places the transmitter on the back over the synsacrum at or near the center of gravity. A single piece of elastic beading cord was tied into two loops with a stretched length of 50–55 mm for each loop and glued to the bottom of the transmitter with cyanoacrylate glue. This loop length held the transmitter in place without being too tight on adults and was sufficiently snug on juveniles to hold the transmitter in place until the bird reached full size. The transmitter was attached by slipping a loop over one leg and between the thigh and body. The transmitter was held in place on the bird's back with one hand (the one holding the bird) while with the other hand holding the opposite leg against the bird's body and slipping the remaining loop over the tibiotarsal-tarsometatarsal joint from the back. The loop was then moved over the foot and between the bird's body and thigh. The antenna extended past the tail and the bird would eventually preen the transmitter into the feathers so the only thing visible was the antenna.

Once juveniles were within 2–3 days of fledging, a Federal aluminum leg band (no color bands) was attached along with a radio transmitter. All birds in a nest received transmitters if they appeared healthy and were suf-

ficiently large to carry the transmitter (i.e., ≥60 g).

The battery life for transmitters was between 9 and 11 weeks, and had a ground-level line-of-sight range of ~2 km. We started locating birds when nests failed or young fledged. The monitoring period was 11 July–6 September in 2002, 4 June to 16 September in 2003, and 3 June to 8 September in 2004. We located birds every 3 days at random times from sunrise to 1800 hrs CST. The signals were used to home in on the location of the radio. If no movements could be discerned, the observer attempted to locate the bird visually to rule out mortality or transmitter loss. Because most of the land in the study area was privately owned and permission for access could not be obtained for every field used by the meadowlarks, regardless of property ownership, locations were recorded to habitat patch and type.

Frequencies of transmitters for which contact was lost were monitored while driving roads in the study area using a scanning receiver and roof-mounted omni-directional antenna to try to relocate the signals. Frequencies were checked from a fixed-winged aircraft toward the end of the season each year to locate birds that were undetectable from the ground.

*Statistical Analyses.*—Distances between fields were measured in ArcView GIS (Version 3.2; Environmental Systems Research Institute 1996). The exact location of a bird in a field could not be ascertained in most cases because of access and we measured distances from the center of the nest field to the center of the field where the bird was located. Location data were assigned to the following habitat types for analysis: CRP (cool-season exotic grasses, primarily smooth brome [*Bromus inermis*]), pasture, remnant prairie, and crops (including alfalfa, strip crops, or other agricultural fields).

The post-breeding period for adults was defined as the time after they successfully fledged chicks or after a nest was lost. Only data after the end of the second nesting attempt were analyzed for two birds that renested in 2004. The post-breeding period for juveniles was after the birds left the nest. This period was divided into fledging and independence intervals with these being 1–21 days after juveniles left the nest and >21 days after the juveniles left the nest, respectively, following Kershner et al. (2004b).

Individuals that lost their radios, had faulty radios, died before the end of the season, or moved from the study area were deleted from further analysis. We only analyzed adult females as only three adult males were radiomarked. We tabulated locations for each individual by habitat and included nesting field as a separate category. We calculated the proportion of locations that occurred in the nest field for the entire post-breeding period for adults. The proportion of locations that occurred in the nest field for the fledging and independence intervals was calculated separately for juveniles.

We tested whether successfully nesting adult females tended to stay more in their nest field compared to those that were not successful. We used ANOVA to test whether these proportions differed by nesting habitat. We tested if the proportion of nest field locations was the same for the two intervals using a paired *t*-test for juveniles. We used the arcsin-square root transformation on all proportions. Tests were done in S-Plus 6.2 (Insightful Corporation 2001).

We were interested in learning if adults tended to move to the same habitat type where they had nested. Equal use of habitats was tested using a Chi-squared test. Analyses were done in StatXact (Mehta and Patel 1999). We calculated the average (± SE) distance moved from the nest field and the average maximum distance moved for all birds. We tested whether distances moved by successfully nesting adult females were the same as unsuccessfully nesting adult females using *t*-tests. Tests were done in S-Plus 6.2 (Insightful Corporation 2001).

## RESULTS

### Transmitter Loss and Mortality

We attached transmitters to 31 adult female Eastern Meadowlarks (13, 7, and 11 in 2002, 2003, and 2004, respectively) and 41 juveniles (16 in 2003 and 25 in 2004). Nineteen females were nesting in CRP, five in pasture, and seven in remnant prairie. Twelve of the juveniles were from nests in CRP, seven from nests in pasture, and 22 from nests in remnant prairie.

Nine females (29%) and 2 juveniles (5%) lost their transmitters. The largest number of birds losing their transmitter, eight adult females, occurred in 2002 when we were refining the attachment technique. No birds lost radios in 2003 and only one adult and two juveniles lost transmitters in 2004. Transmitter loss, rather than death, was assumed because there were no signs of depredation (e.g., no tooth or other marks on transmitter, no feathers or body parts present). We were able to confirm loss of five of six transmitters on adults (i.e., color-banded birds observed after the transmitters were recovered) but neither of the two transmitters on juveniles. No confirmed radio failures were documented.

Mortality likely occurred for one adult (3%) and 12 juveniles (29%) over the 3 years of study. The transmitter from an adult meadowlark was found on the ground among feathers. Two juveniles were found dead; one had a broken leg (the band was on the intact leg). The other 10 juvenile mortalities were inferred from recovery of the transmitter. The radios were recovered with signs of predation; predators usually pulled off the leg with the band and the transmitter and feathers were often present. Eight transmitters were recovered in grassy habitat and two transmitters were found in woods.

## Movements

*Adults.*—Twenty-two adult females retained their transmitter to the end of the monitoring period (71%); 14 females successfully fledged their young and eight did not. Twenty-one females stayed within the study area. The one female that moved from the study area in 2002 nested unsuccessfully in pasture and was found 53 days later in a CRP field, 22 km south of the nest field.

Adult females were found 58% of the time in their nest field (SE = 0.07, $n$ = 21 birds; average locations per bird = 10 [range = 5–18]). This percentage did not differ by nest success ($F$ = 0.65, $df_{1,2}$ = 1, 19; $P$ = 0.43). Successful breeders ($n$ = 14) were found 63% of the time in their nest field (SE = 0.08, 95% CI = 44–73%); unsuccessful breeders ($n$ = 7) were found 49% of the time in their nest field (SE = 0.14, 95% CI = 46–80%). There appeared to be a difference in proportion of locations in the nest field by nest field type ($F$ = 5.58, $df_{1,2}$ = 2, 18; $P$ = 0.013). However, this result was affected by two females which nested in pasture and were not located outside of their nest field. Focusing on females which nested in CRP and remnant prairies showed no difference in proportion of locations in the nest field by nest field type ($F$ = 2.7, $df_{1,2}$ = 1, 17; $P$ = 0.12).

The majority of adult females moved outside the fields where their nests were located. Only three adult females were not found outside their nest fields; two were successful nesters in pasture and one was an unsuccessful nester in CRP. Females moved, on average, 590 ± 80 m from the nest field ($n$ = 18, 95% CI = 419–759 m). The average maximum distance females were located was 662 ± 86 m ($n$ = 18, 95% CI = 480–844 m). Successful and unsuccessful breeders moved the same average and maximum distances from the nest field (average distance: $t$ = −0.35, df = 16, $P$ = 0.73; maximum distance: $t$ = −0.37, df = 16, $P$ = 0.72). Once a female left the nest field, 61% (11 of 18) did not return.

Eleven of 18 females that moved at least once nested in CRP and seven nested in remnant prairie. Of the adults that nested in CRP, about one third moved primarily to other CRP fields, the rest moved to other habitats (Table 1). All adults that nested in remnant prairie moved to other habitats (Table 1). Adults that nested in CRP and in remnant prairie did not differ in types of habitats to which they moved (once they moved from the nest field) ($G$ = 3.4, $P$ = 0.38).

*Juveniles.*—Twelve juveniles from different broods survived to the end of the monitoring period and had multiple observations in the fledging and independent intervals (Table 1); juveniles were tracked an average of 53 ± 6 days (SE) post-fledging ($n$ = 12). There were 8 ± 0.8 (SE) locations per bird; 4 ± 0.3 locations during the fledging interval and 4 ± 0.8 during the independent interval. These 12 juveniles stayed in the study area but two other juveniles moved from the study area. A juvenile from a nest in 2003 in a CRP field was found in a CRP field 8.8 km from the nest field. A juvenile from a nest in remnant prairie in 2004 was found in a pasture 6.6 km from the nest field.

Juveniles were twice as likely to stay in their nest field during the fledging interval

TABLE 1. Modal habitat used by Eastern Meadowlarks that stayed in the Military Ridge Prairie Heritage Area in the post-breeding season, southwestern Wisconsin, 2002–2004.

| Age | Nest field | Total number of birds | Remained in nest field | Habitat moved to: Conservation Reserve Program field | Remnant prairie | Pasture | Crop |
|---|---|---|---|---|---|---|---|
| Adult | Conservation Reserve Program field | 12 | 1 | 4 | 0 | 4 | 3 |
| | Remnant prairie | 7 | 0 | 4 | 0 | 3 | 0 |
| | Pasture | 2 | 2 | 0 | 0 | 0 | 0 |
| Juvenile | Conservation Reserve Program field | 3 | 1 | 0 | 0 | 1 | 1 |
| | Remnant prairie | 7 | 1 | 2 | 1 | 1 | 2 |
| | Pasture | 2 | 0 | 1 | 0 | 1 | 0 |

(proportion of nest field locations, mean ± SE = 0.89 ± 0.08) as during the independent interval (mean ± SE = 0.41 ± 0.10) (paired $t$ = 3.5, df = 11, $P$ = 0.005). Two juveniles did not move from their nest fields during the monitoring period (one was from a nest in remnant prairie and the other was from a nest in a CRP field). Two of the 10 juveniles that moved at least once moved into the same habitat type in which they were hatched; the other eight moved into habitats different from their nest fields (Table 1). Average distance moved was 499 ± 103 m ($n$ = 10, 95% CI = 266–732 m). The average maximum distance moved by juveniles that stayed in the study area was 526 ± 107 m ($n$ = 10, 95% CI = 285–768 m). Once juveniles started to leave the nest field, 67% (8 of 12) did not return there.

## DISCUSSION

Adult female meadowlarks in the MRPHA were in the field where they nested almost half of the time regardless of nest fate; most birds that moved from the nest field moved to grassy habitats. Adults that nested in prairie did not move to other prairies when they moved. However, prairie is relatively rare in the MRPHA (<1% of land use), most remnants are small (<1 ha), and other equally suitable habitats (e.g., CRP) were available closer to the nest field than another prairie remnant. Adult females moved less than a kilometer on average from the nest field regardless of the outcome of the nest attempt, and these movements were interspersed with returns to the nest field. Our results contrast with observations from Illinois (Kershner et al. 2004a) where 44% of females emigrated following nest completion; the Illinois study area comprised approximately 800 ha of managed grassland in a matrix of row crop agriculture, primarily corn and soybeans.

Distances moved by juveniles in Wisconsin were less than those observed in Illinois. The average maximum distance moved by juveniles from the nest field in the MRPHA was about 0.5 km whereas the majority of last known locations for juveniles in Illinois were 1–5 km from the nest site (Kershner et al. 2004b). Only two juveniles in the MRPHA were known to have moved from the study area.

Juveniles usually stayed in the nest field until independence in the MRPHA after which most moved from the nest field into grassy habitats. Kershner et al. (2004b) reported that over 45% of locations of juveniles were in soybeans, while most juveniles avoided corn, pasture, hay, fallow, and residential areas in Illinois. Crop fields were important for juvenile meadowlarks in Missouri (Suedkamp Wells 2005) but, in contrast to Illinois, pasture was also an important habitat. The low use of crop fields in the MRPHA may be related to landscape composition and the relatively low availability of crops. Soybeans and grass/pasture comprised 39 and 18%, respectively, of the study site in Illinois (Kershner 2001) versus 30% (all row crops and strip crops combined) and 27% (idle grass and pasture combined) for the MRPHA. Most (if not all) nest fields in the MRPHA had soybeans or strip crops (usually soybeans and/or corn with alfalfa) within 400 m; despite easy access, birds spent little time in those areas. This may indicate that foraging opportunities are superior or predation risk is lower in grass habitats

than in crop fields in the MRPHA. Because of the short growing season in Wisconsin, soybean plants do not grow as tall as in more southerly locations (D. J. Undersander, pers. comm.) and may not provide adequate cover from predators.

We did not see juveniles using areas with woody cover as Suedkamp Wells (2005) did in Missouri. She suggested that use of areas with woody cover was associated with predator avoidance, particularly snakes, which were the dominant predator in that system; snake activity was observed to be lower in areas of woody vegetation than in open grasslands. Snakes, while present, did not appear to be a dominant predator in the MRPHA (Anderson 2005).

Our results do not indicate any particular management strategy is needed in the MRPHA for post-breeding or fledgling Eastern Meadowlarks other than maintaining or increasing the amount of grass on the landscape. There do not appear to be any specific habitats into which birds are moving during the post-breeding-season period before migration, nor are birds moving from the nesting field during the juvenile fledging period. Other research has found crop fields, especially soybeans, to be used frequently by meadowlarks (Kershner 2001, Kershner et al. 2004b, Suedkamp Wells 2005) but we observed Eastern Meadowlarks in crops (including hay) only rarely. Coupled with the apparent rarity of long-distance movements, this suggests that conditions in the MRPHA are at least adequate to meet the needs of post-breeding and fledgling Eastern Meadowlarks and are possibly superior to nearby areas.

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